California ISO Comments on
Integration of Wind Generation into Power System Operations
December 1, 2004

California now has over 2000 megawatts of installed Wind Generation capacity. Over the past 7 years the California ISO has learned a lot about the integration of this resource into the daily operation of the power grid. At first, we thought all wind generation should be treated the same as any other generating resource and that it should follow the same set of tariff rules. Scheduling wind generation energy in the day-ahead market created unacceptable risks of imbalanced energy charges for them and did not solve some of the problems of control area operations. Wind Generation was unscheduled and unpredictable and seemed to show up in real-time as "must take" generation. A primary operating problem was the potential for over-generation at night when loads were low and wind generation production cranked up to its maximum value.

The California ISO started working with the Wind Generation owners to better understand the operation of this resource. We learned that we could forecast wind energy production 1 to 2 hours in advance with acceptable accuracy. These relatively accurate short-term forecasts allowed this energy to be scheduled in the hour-ahead market. Unfortunately day-ahead wind energy forecasting was still relatively inaccurate. We could also take some of the surprise out of wind generation production by providing the Operations Dispatchers with 1 and 2-hour ahead forecasts. The CAISO created a special program called the Participating Intermittent Resource Program (PIRP) for wind generators and other renewable resources that allows them to schedule their energy in the hour-ahead market. Jim Blatchford from CAISO will describe the PIRP program in his presentation.

Based on our experiences, there are 5 key findings we would like to share with you.

1. SCADA data from the wind generation sites with 10 megawatts or more of capacity is essential for both reliable operation of the power grid and for accurate forecasting of energy production. It is vital to have updated data at least every minute and preferably every 4 seconds, which is the same data requirement we have for other generation resources. Data from the site should include not only the watts and vars from the facility but also the meteorological data such as wind speed, wind direction, temperature and barometric pressure.
2. Forecasting of wind generation energy production is essential for both scheduling the energy into the markets and reliable operation of the power system. We are striving for accurate 5-minute interval forecasts for up to 3 hours in advance of real-time, plus accurate hourly forecasts for up to 7 hours in advance for our unit commitment program. Work is continuing on improving day-ahead forecasts to improve resource scheduling and improving the calculation of ancillary services that should be procured for the next day's operations. We need more locations that report weather data and we would encourage the Federal Government to fund additional meteorological reporting sites and improved longer term forecasting models.

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3. Maximum Wind Energy production at night continues to be a problem as we have trouble finding a sink for this energy. Turning off other generators is often the only solution but the new Combined Cycle Generating Plants have difficulty cycling off at night and then restarting quickly for the morning load pull. There is a real need for new energy storage capability that can absorb some of the off peak energy production by wind generators and then pump the energy back into the system during peak load hours. We would like to see the Department of Energy significantly increase the R&D funding for energy storage technology that could complement the wind energy.
4. Large energy production changes by wind generators within short periods of time can make major impacts on the amount of regulation services needed to control system frequency. Wind Generation energy production in California has a highly seasonal component. In the January through March period, our loads are at minimum levels and the amount of generation needed is low. Big pacific storms can rapidly drive wind generation to maximum values. They can also produce gusts that result in the wind generators being forced to trip off line and the energy production will drop from a maximum value to zero. We have other periods where the energy production rapidly ramps up by 700 MW within an hour. The amount of regulation procurement should include a factor to mitigate the impact of these large fluctuations in wind energy production. Again, day-ahead forecasting of these potential ramps is a critical component in the effective procurement of ancillary services. The wind generators and the ISO need to work together on operating practices and strategies to limit large ramps where possible.
5. There is significant value in the diversity of wind generation locations and aggregation of large amounts of wind generation. Northern California locations and Southern California locations see very different wind patterns. While the energy production from a few turbines in one area can rapidly vary, when the energy production from a 1000 turbines from 5 different sites in a large area are aggregated, many of the rapid changes disappear. The aggregated energy production is more even and easier to forecast. So system control problems do not necessarily increase linearly with the increase in the amount of installed wind generation.

Finally, a close working relationship between the generators, the schedulers and the grid operators is essential. This can result in the creation of tariff rules that encourage renewable resources and the creation of operating practices that ensures that reliability needs are meet.

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